National Academy of Sciences
National Research Council
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Attachment A

Interim Report
to
SPACE SCIENCE BOARD

of
Biology Committees (11 and 11-A)

The Space Science Board Committee on Psychological and Biological Research, and its Exobiology Sub-committee has given careful consideration to the tasks outlined in SSB-139 and its attachments. The Committee is now reorganizing to improve the biology coverage in the space science programs of the 1965-70 and 1970-80 periods. Completion of this reorganization will make possible the broad assessment necessary to provide a properly balanced biology input to program formulation.

1970-80 Period and the late 1960's (particular reference to exobiology)

Within the foreseeable future, the cost of sending an experimental device through space and receiving information from it will be many times that of using comparable analytical instruments in the laboratory. For many other reasons, the retrieval of samples of the planets would ultimately be the most informative means for the advancement of planetary science. This self-evident design has been and should continue to be foremost in the long-range planning for the scientific utilization of spacecraft with the requisite capabilities. However, such missions also introduce the risk of back-contamination, a risk that cannot be decisively evaluated within the framework of our present knowledge of planetary biology. The same missions, as well as the one-way probes that will precede them, also entail the possibility of contaminating the targets; however, these missions can be programmed so as to minimize the carriage of "samples" of the earth, and to disinfect the spacecraft by methods of known efficacy for terrestrial organisms. Furthermore, as a matter of policy, acceptable risk figures for contaminating a planetary target must be substantially higher than for bringing trouble home.

From this standpoint, it may be fortunate that the vehicles for one-way missions will (as is obvious) become available first. We must make every effort to develop experiments that can be flown on such missions and give telemetered information on planetary life and life-habitats.

<u>1960-65 Period</u>

During this time, Centaur will be available, but Saturn will not. The most significant experiments in exobiology are not possible with these capabilities: these require planetary soft landings, however, considerable preparatory work must be done now. This consists of two parts—both, for this period, independent of sequence.

1) Space Experiments

   a) Lunar soft landing
   b) Planetary fly-bys
   c) Satellite-borne telescope
   d) Recoverable nose-cone or satellite capsule

2) Back-up research, for space flight experiments and for general scientific information

   a) Instrumentation
   b) Earth-based experimentation

Many aspects of the planetary chemistry program are of particular interest to the biology groups; in fact, there is no chemical information not useful to planning biological experiments.

A. <u>Exobiology</u>

1) <u>Space Experiments</u>

a) <u>Lunar Landing</u> - Biologists await anxiously the chemical analysis of the lunar surface and of deeper layers. These results are essential for planning any biological approach, until this information is available, however, we continue to stress the necessity for minimizing contamination of the moon by terrestrial organisms.

b) Planetary Fly-bys

i) Determination of the temperature profile of Venus

ii) Examination of Mars in the infra-red as proposed by Davis and Gumpel in their COSPAR Symposium paper. This experiment was conceived by Jet Propulsion Laboratory in collaboration with Messrs. Calvin and Weaver of the University of California. It is understood that the instrumentation is essentially ready.

c) Satellite Telescope - This experiment can, under certain conditions of technological development, provide essentially the same information as the fly-bys, either would be helpful depending on the solution of their respective technology problems. It is very important to have planetary study capability included in the satellite telescope.

d) Recoverable Nose-cone or Satellite Capsule

i) Temperature relations of small particles in vacuum under incident radiation. Particles whose diameter is less than IR wavelengths may reach very high equilibrium temperatures owing to their difficulty of the radiation. It may be possible to simulate the reaction of, say, ~~f~~bacterial spores ($d \doteq 1\ \mu$) in vacuum in the terrestrial laboratory, but it may be difficult to prevent interaction between particles and container wall. Space experiments, e.g. recoverable satellite capsule and nose-cone flights (giving as much as 30 minutes exposure) may be the most convenient way to determine the effect.

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b

ii) Study of the effects of the low pressures of free space on the survival of terrestrial organisms. ~~This~~ To a considerable extent it may be possible to simulate this on the ground~~, although exposure to the space environment would be more meaningful.~~
(Halverson of Wisconsin is interested in both i and ii.)

~~though~~, As with radiobiological experiments, final assessments should be made empirically in space with ~~indicator~~ test systems that have been thoroughly worked out on the ground.

no

2) **Back-up Research**

Throughout this period, continuing research on every aspect of the control of contaminating organisms in anticipation of soft landings on the moon, and more particularly the planets, must continue.

a) Instrumentation for Space Flight Experiments

i) Gathering of samples of planetary surface materials for analysis. This problem ~~[illegible]~~ needs fundamental ~~[illegible]~~ review.

Electrostatic collection of falling dust
Scoops or augers
~~(Perhaps an analysis of this problem is needed.)~~

ii) Chemistry of planetary surfaces

Application of mass spectrometer techniques to solid as well as gaseous samples
Automatic spectrometry in infrared and ultraviolet
Handling of materials for chemical analytical reactions
Detection of micron-sized particles giving volatile products

iii) Protection of samples

Encapsulation of samples in hermetically-sealed containers for (a) local protection for later analysis and (b) ultimately for safe return to earth.

iv) Biological detection

Culture and micro chemistry of micro-organisms
(Vishniac and Lederberg both interested)

v) Means for subsequent location and identification of space craft (and components) used in early planetary landings

vi) Means for vidicon survey at various magnifications and focal lengths for macroscopic exobiota (and for other planetary data)

(vii) Detectors for enzymatic catalysis
Interaction of planetary organisms with tissue cells
Response of planetary organisms to disinfection

b) Ground-based Experimentation for General Scientific Information

i) Telescopy - particularly continuing planetary studies

ii) Analysis of meteorites

iii) Profile of earth's atmosphere with respect to microbe-bearing dust

Sample collection by high altitude balloons, and sounding rockets; also micrometeorites thus collected can be analyzed for abundances of carbonaceous materials.

The transport of micron particles can be determined through studies of high altitude atmospheric turbulence.

Consideration of the mechanisms necessary for organisms to escape the earth's ~~magnetic~~ gravitational field.

iv) Interpretation of the appearance of earth from high altitude for detection of biological phenomena— both high resolution photography and in IR.

v) Simulation of planetary environments as habitats for terrestrial organisms

vi) Conditions for the origin of life/simulation of planetary atmospheres and characterization of products of biochemical interest resulting from their irradiation~~s~~.

B. Radiation Biology

1) Space Experiments - More detailed physical measurements of the radiations in space. When known reliably, these measurements can be translated easily into biological terms by (a) laboratory simulation and (b) calculations from fundamental parameters.

Cosmic ray effects. These effects at a cellular level are pretty well understood, but their heterogeneous distribution over the animal (needle-like lesions 25 μ diameter, 1 mm long) gives effects on performance of the whole animal not yet easily calculated.

2) Back-up Research - Experiments with available accelerators and microbeam equipment will enable selection of the best biological indicators to be used later in flight tests.

C. <u>International Co-operation</u>

1) Development of acceptable methods of decontamination

2) Exchange of ideas concerning the objectives of exobiological research and discussion of the instrumentation

agreements

3) Depending on success of these enterprises negotiation of tacit ~~arguments~~ through COSPAR.

D. <u>Environmental Biology</u>

No serious proposals for rhythms or gravity-free state experiments were at hand.